BULLETIN OF THE IMPERIAL INSTITUTE

QUARTERLY RECORD OF PROGRESS IN TROPICAL AGRICULTURE AND INDUSTRIES AND THE COMMERCIAL UTILISATION OF THE NATURAL RESOURCES OF THE COLONIES AND INDIA

EDITED BY THE DIRECTOR AND PREPARED BY THE SCIENTIFIC AND TECHNICAL STAFF OF THE IMPERIAL INSTITUTE AND BY OTHER CONTRIBUTORS

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CONTENTS

CONTENTS

SPECIAL ARTICLES

GENERAL ARTICLES

NOTES

CONTENTS

THE IMPERIAL INSTITUTE

OF THE

UNITED KINGDOM, THE COLONIES, AND INDIA

THE Imperial Institute was erected at South Kensington as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May 1893.

The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire: (i) by arranging comprehensive exhibitions of natural products, especially of the Dominions, Colonies and India; and (ii) by providing for their investigation, and for the collection and dissemination of scientific, technical and commercial information relating to raw materials.

Until the end of 1902 the Imperial Institute was managed by a Governing Body, of which H.R.H. the Prince of Wales (afterwards King Edward VII.) was President, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In 1900 the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Governing Body of the Imperial Institute, the greater part of the eastern and central portions being assigned, subject to rights of usage, for occupation by the University of London. In July 1902 an Act of Parliament was passed transferring the management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of the Dominions, Colonies and India, as well as of the

Colonial and India Offices, the Board of Agriculture and the Board of Trade.

In April 1916 the Imperial Institute (Management) Act was passed transferring the property and management of the Imperial Institute to the Secretary of State for the Colonies. The Act provides for the appointment of an Executive Council consisting of twenty-five members, nominated by the Board of Trade, the Secretary of State for India (two each), the President of the Board of Agriculture and Fisheries, the Government of India, the Governments of the several Dominions (one each), and the Secretary of State for the Colonies (fourteen). A list of the present members of the Council is given on pp. x, xi and also of the various Committees which have been appointed (pp. xi–xv).

The staff of the Imperial Institute includes officers with special qualifications in the sciences of chemistry, botany, geology and mineralogy, and in certain branches of technology, in their relation to commerce and to the industrial utilisation of raw materials.

The following are the principal departments of the Institute:

Public Exhibition Galleries. — The collections of raw materials, etc., illustrative of the industrial and commercial resources of the Dominions, Colonies and India, are arranged, together with other exhibits, on a geographical system in the public galleries of the Imperial Institute. The galleries are open free to the public, daily (except on Sundays, Good Friday and Christmas Day), from 10 a.m. to 5 p.m. in summer, and from 10 a.m. to 4 p.m. in winter.

The following British Dominions, Colonies and Dependencies are represented by Collections, which are in charge of Technical Superintendents:

Canada, Newfoundland; Jamaica, Turks and Caicos

Islands, British Honduras, British Guiana, Bahamas, Trinidad and Tobago, Barbados, Windward Islands, Leeward Islands, Bermuda; Falkland Islands; New South Wales, Victoria, Queensland, Tasmania, South Australia, Western Australia, Papua, New Zealand; Fiji, Western Pacific Islands; Union of South Africa, Rhodesia, Nyasaland, St. Helena; Gambia, Sierra Leone, Gold Coast, Nigeria; East Africa Protectorate, Zanzibar and Pemba; Uganda; Somaliland; Sudan; Malta; Cyprus; Ceylon; Hong Kong; Mauritius; Seychelles; Straits Settlements, the Federated Malay States; and the Indian Empire.

An Egyptian collection is in course of formation.

A reference collection of standard raw materials of commerce is shown in the Upper East Gallery.

Arrangements are made to conduct parties from schools and educational institutions through the Collections and to explain the exhibits. Short lectures on the countries of the Empire and their resources are given periodically in connection with the Collections.

A Central Stand for the distribution of publications and an Enquiry Office have been opened in the main gallery to provide for the supply of general information and the distribution of literature. Handbooks, pamphlets, circulars, etc., containing information relating to the commerce, agriculture, mining and other industries of the Dominions and Colonies, and also in regard to emigration, are available for free distribution or for sale. The publications of the Emigrants' Information Office may also be obtained. Lists of the publications available for distribution or sale are provided, and the principal Colonial and Indian newspapers may be seen on application.

In 1916 the public galleries were visited by 162,854 persons, and 11,991 publications were distributed.

Scientific and Technical Research Department.—The technical laboratories and workrooms of this Department were

established in order to provide for the investigation of new or little-known raw materials from the Dominions, Colonies and India, and of known products from new sources, with a view to their utilisation in commerce.

The work of this Department is chiefly initiated by the Home, Dominion and Colonial Governments and the Government of India. Arrangements have been also made by the Foreign Office whereby Consular representatives abroad may transmit to the Department, for investigation, such raw materials of the countries to which they are appointed as are likely to be of interest to British manufacturers and merchants.

Special analyses and investigations are also undertaken for firms or private persons in any part of the Empire on payment of appropriate charges. Application for such investigations should be made, in writing, to the Director.

Materials investigated in the laboratories of the Department are in promising cases submitted to further technical trials by manufacturers and other experts, and finally are commercially valued.

A Reference Sample Room is maintained in this Department, in which are arranged samples of the principal raw materials which have been investigated and valued commercially during recent years, and as to which full information is available.

The Department works in co-operation with the Agricultural, Mines and other Technical Departments in the Dominions, Colonies and India, whose operations it supplements by undertaking investigations and enquiries of a special scientific or technical character connected with agricultural or mineral development, as well as enquiries relating to the composition and commercial valuation of products (animal, vegetable or mineral) which can be more efficiently conducted at home in consultation with

manufacturers and merchants, with a view to the local utilisation of these products or to their export.

A large number of reports on these subjects have been made to the Governments of the Dominions, the Colonies and India, a first instalment of which was printed in a volume of *Technical Reports and Scientific Papers*, published in 1903. A series of Selected Reports is now being issued in the Miscellaneous Series of Colonial Reports which are presented to Parliament (p. viii).

Mineral Surveys are conducted in countries of which the mineral resources are little known. All minerals found that are likely to be of commercial importance are forwarded to the Imperial Institute, where they are examined and their composition and commercial value ascertained. Reports on the results of mineral exploration in Ceylon, Northern Nigeria, Southern Nigeria, and Nyasaland have been printed in the Miscellaneous Series of Colonial Reports and presented to Parliament.

Technical Information Bureau.—This Bureau, which is a branch of the Scientific and Technical Research Department, has been formed to deal with the large and increasing number of enquiries received by the Imperial Institute from manufacturers, merchants and others, throughout the Empire. The Bureau has devoted special attention to questions arising out of the war, particularly those relating to the opportunities presented for the development, within the Empire, of industries the raw materials of which were formerly monopolised by Germany. It has supplied technical information to enquirers, and has issued circulars and pamphlets dealing with various problems in connection with the supply and disposal of raw materials.

Indian Trade Enquiry.—The Secretary of State for India has requested the Indian Committee of the Institute to

enquire into and report on the possibilities of extending the industrial and commercial utilisation of Indian raw materials in this country and elsewhere in the Empire. A number of Special Committees have been appointed to deal with the more important groups of Indian materials, to consider the results of investigations and enquiries already conducted at the Imperial Institute, and to obtain the views of leading merchants, manufacturers and other users of the raw materials of India. A list of the members of these Special Committees is given on pp. xiii and xiv.

Tropical African Services Course.—Courses of instruction in certain specified subjects are given at the Imperial Institute to candidates selected by the Colonial Office for administrative appointments in East and West Africa. Instruction in these Courses in the subject of Tropical Economic Products is given by a member of the Staff of the Imperial Institute. The Courses have been temporarily discontinued during the war.

Library, Reading-Rooms, and Map-Room.—The library and reading-rooms of the Imperial Institute contain a large collection of works of reference, and are regularly supplied with the more important official publications, and with many of the principal newspapers and periodicals of the United Kingdom, the Dominions, the Colonies, India and Foreign Countries. Special attention is given to publications relating to tropical agriculture and forestry, mineral resources, and the production and utilisation of raw materials.

The map-room, which adjoins the reading-rooms, is provided with a large collection of recent maps of the Dominions, the Colonies and India, which can be seen on application to the Librarian.

Colonial Conference Rooms.—These rooms, specially decorated and furnished, are reserved on the principal floor for use by representatives of the Dominions and Colonies and for meetings and receptions.

The Cowasjee Jehangier Hall.—The Bhownaggree corridor and rooms in connection with the Cowasjee Jehangier Hall are in the occupation of the Indian Section of the Imperial Institute, whilst the Hall is available for lectures, meetings, etc.

Publications

Bulletin of the Imperial Institute.—The BULLETIN is published quarterly by Mr. John Murray, 50A, Albemarle Street, London, price 2*s.* 6*d.* (annual subscription 11*s.*, including postage), and may be purchased through any bookseller. It contains records of the principal investigations carried out at the Imperial Institute, and special articles chiefly relating to the industrial utilisation of raw materials and progress in tropical agriculture.

Handbooks to the Commercial Resources of the Tropics.—The Secretary of State for the Colonies has authorised the preparation of a series of handbooks dealing with the Commercial Resources of the Tropics, with special reference to West Africa. The handbooks are edited by the Director of the Imperial Institute and published by Mr. John Murray. The first three volumes are: *The Agricultural and Forest Products of British West Africa*, by Gerald C. Dudgeon, Consulting Agriculturist, Ministry of Agriculture, Egypt, and lately Inspector of Agriculture for British West Africa, price 5*s.* net; *Cocoa: Its Cultivation and Preparation*, by W. H. Johnson, F.L.S., Director of Agriculture in Southern Nigeria, price 5*s.* net; and *Rubber: Its Sources, Cultivation and Preparation*, by Harold Brown, Technical Superintendent, Scientific and Technical Department, Im-

perial Institute, price 6*s.* net. A fourth volume, *Cotton and other Vegetable Fibres: their Production and Utilisation*, by Ernest Goulding, D.Sc., F.I.C., Scientific and Technical Department, Imperial Institute, is in the press.

Monographs on Industries.—The Imperial Institute has devoted special attention to the question of securing the utilisation in the United Kingdom of the large quantities of materials produced within the Empire which before the war were exported chiefly to foreign countries. It is intended to deal with this subject in a series of Monographs. In order to call attention to the subject of oil seeds, a monograph, entitled "Oil Seeds and Feeding Cakes," has been issued. This book, which is published by Mr. John Murray, price 2*s.* 6*d.* net, deals with the production and utilisation of copra, palm kernels, ground nuts, sesame seed and mowra seed, and the oils and feeding cakes obtained from them.

Selected Reports from the Scientific and Technical Department.—These reports are issued in the Miscellaneous Series of Colonial Reports, which are presented to Parliament. They contain a summary of the results of technical and commercial investigation of raw materials conducted in the Scientific and Technical Research Department of the Imperial Institute since 1903. Five of these Selected Reports have been published: Part I. "Fibres"; Part II. "Gums and Resins"; Part III. "Foodstuffs"; Part IV. "Rubber and Gutta Percha"; Part V. "Oil-seeds, Oils, Fats and Waxes."

Organisations with Headquarters at the Institute

International Association for Tropical Agriculture, British Section.—The object of this Association, the Central Bureau of which is in Paris, is to promote the scientific and practical study of all questions connected with the

agriculture of tropical countries, including the development and utilisation of natural resources, and to hold periodical International Congresses. The British Section has its headquarters at the Imperial Institute. Members of the British Section are permitted to use the library and reading-rooms of the Imperial Institute.

British Women's Emigration Association.—The British Women's Emigration Association has offices on the mezzanine floor, which are open daily from 10 a.m. to 4 p.m. Advice and information respecting emigration and prospects for women in the Dominions may be obtained there free of charge. This Association works in co-operation with the Emigrants' Information Office in Westminster.

Colonial Nursing Association.—An office on the mezzanine floor has been allotted to this Association, the principal object of which is the selection of trained hospital and private nurses for service in the Crown Colonies and Dependencies.

Tropical Diseases Bureau.—Temporary office accommodation on the mezzanine floor has been provided for this Bureau, the main purpose of which is to collect information regarding tropical diseases and to distribute it as widely as possible among those who are engaged in combating such diseases.

Universities Bureau of the British Empire.—An office on the mezzanine floor has been allotted to this Bureau, the object of which is the collection and dissemination of information relating to the Universities of the British Empire.

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MINERAL SURVEYS.—*Ceylon:* J. S. COATES, B.A. (Cantab.); E. J. WAYLAND, F.G.S.

State of Gwalior, Central India: DOUGLAS R. HOME, F.G.S.; S. M. OWEN, A.R.S.M., F.G.S.

Since the outbreak of war, the following members of the Staff of the Imperial Institute have joined H.M. Forces:

Assistant Secretary to the Director: The Hon. T. L. MCCLINTOCK BUNBURY, M.A. (Cantab.).

Scientific and Technical Staff: G. T. BRAY; H. J. BROUGHTON; W. G. CREASY; W. S. DAVEY; H. JOHNSON,[1] B.Sc. (Lond.); T. MCLACHLAN; G. L. MATTHEWS, B.Sc. (Lond.); V. W. NEWMAN[1]; F. W. ROLFE; D. J. TAYLOR,[1] B.Sc. (Lond.); J. D. F. WEST; B. W. WHITFEILD; W. O. R. WYNN.

Clerical and Labour Staff: K. BLAIR, S. BLAIR, A. BOOTHER, F. BROWN,[2] H. CARTER, H. E. COULSON, F. W. ELDRIDGE, H. FOSTER, C. FURNEAUX, P. FURNEAUX, R. HENDERSON, W. F. MILLER, A. W. POTTER, P. J. REDMOND, F. RICKETTS, J. A. SIMPSON, J. WELLS, I. V. YEATMAN.

Mineral Surveys, Ceylon: E. J. WAYLAND, F.G.S. *State of Gwalior, Central India:* D. R. HOME, F.G.S.

[1] *Killed.* [2] *Missing, assumed killed.*

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Dominion, Colonial and Indian Governments.

SOME NEW PAPER-MAKING MATERIALS

In the following pages an account is given of the results of examination of *Ecdeiocolea monostachya* "leaves" from Western Australia, *Neoboutonia macrocalyx* timber from the East Africa Protectorate, and bark of *Brachystegia Randii* from Rhodesia, which have been investigated at the Imperial Institute recently as sources of pulp for paper-making.

Ecdeiocolea monostachya "Leaves" from Western Australia

E. monostachya, F. Muell., is a rush-like plant belonging to the natural order Restiaceæ, and is found only in Western Australia. The stems or so-called "leaves" are erect, rigid, rather slender, and vary in height from 2 to 5 ft.; they bear a number of sheathing, brown scales at the base, the upper part being bare, except for a single sheath just below the terminal flowering head.

Early in 1916 a sample of the "leaves" was sent to the Imperial Institute from Western Australia, for the purpose of ascertaining whether the material would be of commercial value as a source of fibre for paper-making or other purposes.

The sample consisted of narrow green "leaves" varying from 3 to 5 ft. in length, most of them being about 4 ft. long. The "leaves" were round in cross-section, and measured

about $\frac{1}{8}$ in. in diameter at the base, tapering to less than $\frac{1}{16}$ in. at the apex. The surface of the "leaves" was somewhat waxy.

The "leaves" were examined at the Imperial Institute as a paper-making material with the following results:

Moisture, in the "leaves" as received	*per cent.*	10·1
Ash, expressed on the "leaves" dried at 105° C.	" "	3·0[1]
Cellulose, expressed on the "leaves" dried at 105° C.	" "	49·5
Length of ultimate fibres		2·0 to 5·4 mm. (0·08 to 0·22 in.)

[1] *Containing* 40·1 *per cent. of silica* (SiO_2).

The "leaves" were treated by a method similar to that employed on a large scale for the preparation of paper-pulp from esparto grass, *i.e.* they were digested under pressure with 16 parts by weight of caustic soda, of 4 per cent. strength, for 4 hours at 140° C. The following result was obtained, in comparison with those given by two commercial specimens of esparto grass treated in the same way:

	Yield of pulp from air-dry material. *Per cent.*
E. monostachya "leaves"	44
Spanish esparto grass	52
Algerian esparto grass	42

From these results it is evident that *E. monostachya* "leaves" yield about the same amount of pulp as Algerian (Oran) esparto grass. The pulp is, however, inferior in appearance to that yielded by esparto grass, and the unbleached pulp yields a darker-coloured paper, whilst the pulp is somewhat difficult to bleach. Further, the paper prepared from *E. monostachya* "leaves" shows small bright yellow specks, due to the presence of a waxy or resinous substance, of which the "leaves" yield about 2·7 per cent. on extraction with alcohol. This latter defect can be, to a very large extent, prevented by more drastic treatment, *e.g.* by boiling the "leaves" with 20 parts instead of 16 parts by weight of caustic soda, and this treatment also considerably improves the colour of the bleached pulp, though it must be added that at the same time it reduces the yield of dry unbleached pulp from the air-dry "leaves" from 44 to 39 per cent., and the paper shrinks considerably on drying.

Specimens of the "leaves" and of bleached and unbleached paper prepared from them by the normal treatment were submitted to a firm of paper manufacturers, who were of opinion that the material would yield a paper having some of the characteristics of the papers yielded by esparto grass, straw and bamboo, but in certain respects superior to all three. The firm added, however, that in normal times these Ecdeiocolea "leaves" might not sell at a higher price than Algerian esparto grass (say £3 5s. per ton c.i.f. London), and they considered it doubtful whether paper-makers would substitute the "leaves" for esparto grass if the price were materially higher.

From the results of this investigation it is clear that these Ecdeiocolea "leaves" would form a valuable raw material for the manufacture of paper. They could not be exported from Australia to the United Kingdom in the raw state, as such materials fetch low prices, but they could be used in Australia for the manufacture of pulp and paper of high quality, either for local use or for export.

A sample of the "leaves" and a small specimen of fibre extracted from them were submitted to fibre experts. They reported that the fibre was somewhat harsh for spinning purposes, and was short, brittle and deficient in strength, and they considered that it would be of little or no commercial value.

A few experiments were made at the Imperial Institute on the extraction of fibre from the leaves. This proved to be a difficult and tedious operation, though it may be somewhat easier when fresh leaves are used. It seems unlikely that any existing fibre-extracting machinery could be used for the extraction of the fibre, and special machinery would probably have to be devised. In view of the poor quality of the fibre, as extracted by hand, it scarcely seems worth while to consider the question of special machinery, but it might be possible to prepare the fibre from the fresh leaves by a retting process, such as that used in the case of jute or flax, and it was suggested to the Australian authorities that a few pounds of fibre should be prepared in this way if possible for further examination and commercial valuation.

Neoboutonia macrocalyx Timber from the East Africa Protectorate

N. macrocalyx, Pax (Nat. Ord. Euphorbiaceæ), is a medium-sized tree, which attains a height of 50–60 ft. and a diameter of 15–20 in. It is peculiar to tropical Africa, being found in Uganda, East Africa Protectorate and German East Africa. According to information supplied to the Imperial Institute by E. Battiscombe, Conservator of Forests, East Africa Protectorate, the tree is extremely abundant in the forests of the Kikuyu Escarpment and Aberdare Mountains in that Protectorate, where it grows at an elevation of 7,000–9,000 ft. It reproduces itself readily from seed, and the young trees are fast-growing. When growing in dense formation it produces a straight bole free from branches. The timber is difficult to saw into boards or scantling on account of its "woolly" nature, and it is of little value in the building or joinery trade. The only use to which it might be put would be for making rough crates, but at present there is no demand for these in East Africa.

With a view to ascertaining the value of the timber as a source of pulp for paper-making, specimens were sent to the Imperial Institute in January 1916. The material consisted of two pieces of timber, each measuring 2 × 4 in. in cross-section and 2 ft. in length. The total weight was 6¼ lb. The wood was mostly yellowish in colour, with greyish markings. It had a "woolly" surface, and was soft and light.

Attempts to smooth the surface of the wood by planing were unsuccessful, and the freshly sawn surface, although not showing loose fibres, was very soft. The timber was free from knots.

The timber was examined at the Imperial Institute with the following results:

Moisture (in wood as received)	*per cent.* 10·5
Ash (expressed on the dried wood)	„ „ 1·9
Cellulose („ „ „)	„ „ 61·0
Resin („ „ „)	„ „ 3·5
Length of ultimate fibres	from 0·04 to 0·05 in.

The results of a series of four paper-making trials carried out at the Imperial Institute are shown in the

following table, together with corresponding figures for a sample of spruce wood examined under similar conditions, for comparison :

Experiment No.	Parts of caustic soda per 100 parts of wood.	Parts of caustic soda in 100 parts of solution.	Conditions of boiling.		Yield of unbleached pulp, expressed on the timber as received.
			Hours.	Temperature.	
					Per cent.
1	16	4	3½	144° C.	about 50
2	16	4	5	144° C.	
3	20	4	4	144° C.	
4	24	6	7	165° C.	46
Spruce wood	24	6	7	165° C.	42

Under the conditions of experiments 1, 2 and 3, the wood was not thoroughly broken up, but it could be converted into a workable pulp by prolonged beating. The unbleached pulp thus obtained produced a brown paper, which did not shrink on drying and was opaque. The pulp bleached easily, and yielded an almost opaque paper of good strength.

More drastic treatment, *i.e.* under the conditions of experiment 4, reduced the wood to a condition in which it was easily converted into pulp. The colour was considerably improved by this treatment, which, moreover, was only attended by a loss of about 4 per cent. in the yield of unbleached pulp. The resulting paper did not shrink on drying, and was strong and opaque. The pulp bleached easily, and yielded an opaque and almost white paper.

It is evident from the foregoing results that the wood of *N. macrocalyx* yields a good pulp, when it is treated under conditions similar to those of the "soda" process employed on the large scale for pulp manufacture from spruce and other soft woods. The ultimate fibres are rather shorter than those of spruce wood, but the pulp felts well, bleaches easily, and yields a strong paper. The yield of pulp is rather higher than in the case of spruce, and the timber should therefore form a good source of paper pulp. Before definitely recommending the timber for the manufacture of wood pulp and paper, however, it will be necessary to have a large scale trial with several tons of wood, carried out at a paper-mill.

Brachystegia Bark from Rhodesia

A sample of bark was received from Rhodesia for examination in September 1916, together with herbarium specimens of the tree from which it was derived. The herbarium specimens were submitted to Kew, where the plant was identified as *Brachystegia Randii*, Bak. f. (Nat. Ord. Leguminosæ). This is a large tree, known in the vernacular as "musasa," and is exceedingly common throughout the greater part of Mashonaland, where it forms extensive forest and woodland. The timber is soft and of little value commercially, although it is commonly used by the natives for hut building.

The sample received at the Imperial Institute consisted of ribbons of the inner bark of the plant, measuring 2 to 8 ft. in length and up to 1 in. in width. The material was mostly of a light brown colour, but a fair proportion was dark reddish-brown. A small amount of adherent outer bark was present on some of the ribbons.

A small quantity of fibre was prepared from the sample at the Imperial Institute by boiling with dilute sodium carbonate solution, but it was found to be much interlaced and therefore unsuitable for spinning purposes. It seems possible that by retting the bark ribbons a coarse fibre suitable for rope-making might be obtained, but it is unlikely that such fibre would be of much value.

The bark was examined as a paper-making material, with the following results:

Moisture in material as received	*per cent.*	11·8
Ash, expressed on the dried material	,,	3·4
Cellulose, expressed on the dried material	,,	43·0
Length of ultimate fibres		from 0·05 to 0·10 in.

The results of a series of three paper-making trials carried out at the Imperial Institute are shown in the following table:

Experiment No.	Parts of caustic soda per 100 parts of material.	Parts of caustic soda in 100 parts of solution.	Conditions of boiling.		Yield of dry unbleached pulp, expressed on the material as received.
			Hours.	Temperature.	
					Per cent.
1	16	4	4	140° C.	35·0
2	24	4	4	140° C.	32·0
3	20	4	6	154° C.	34·0

The unbleached pulp was in all three cases of dark colour, and yielded a strong, opaque, dark brown paper. The pulp bleached easily and quickly and yielded a white opaque paper, which did not shrink on drying and was of good quality.

It seems unlikely that a fibre of value for textile or cordage purposes could be prepared from this Brachystegia bark, and the latter is more likely to be of use for paper making. The bark would only yield about 33 per cent. of unbleached pulp, which is distinctly low for a paper-making material, but the pulp is of good quality, and the bark would no doubt be saleable if offered in large and regular quantities. The export of the bark from Rhodesia is, however, not likely to prove remunerative as it would probably not realise more than £5 per ton in normal times in the United Kingdom, in competition with baobab bark, which contains 60 per cent. of cellulose and is worth £7 to £8 per ton. It would therefore be necessary to convert it into "half-stuff" in Rhodesia and ship it in this form to Europe.

For the manufacture of "half-stuff" soda and other chemicals would be required, as well as considerable supplies of fuel and water, and in view of this it is doubtful whether a pulp industry would be remunerative in Rhodesia. An important point in this connection is the quantity of the bark likely to be available and the cost of collection; but information on these points is not yet available.

FIBRES FROM VARIOUS SOURCES

In the following pages an account is given of the results of examination of a number of fibres which have been investigated at the Imperial Institute in recent years.

Jute from Egypt

A sample of jute obtained from plants grown from Indian seed in the Horticultural Gardens, Cairo, was received in August 1916. It had been prepared by a special process. The fibre varied greatly in colour, being

mostly light reddish-brown, with a small portion of a buff tint. It was soft, clean and well-prepared, but on the whole had little lustre. The strength was rather irregular, but on the whole good. The length of the fibres varied from 5 to 9 ft., being mostly from 6 to 7 ft.

The sample was submitted to chemical examination, with the results given in the following table, which shows also the corresponding figures obtained for a sample of "extra fine" Indian jute:

	Present sample. *Per cent.*	"Extra fine" Indian jute. *Per cent.*
Moisture	11·1	9·6
Ash	2·7	0·7
α-Hydrolysis, loss	4·4	9·1
β-Hydrolysis, loss	7·6	13·1
Acid purification, loss	4·6	—
Loss on washing in water	2·0[1]	—
Cellulose	76·8	77·7

[1] *Containing* 0·75 *per cent. of alkali calculated as sodium carbonate* (Na_2CO_3).

The fibre was valued by a firm of brokers in London at £36 to £37 per ton c.i.f. London, with Calcutta jute at £41 and "Bimlipatam jute" (*Hibiscus cannabinus*) at £35 per ton (December 1916). The brokers considered that the material would be saleable in large quantities.

The low figures for loss on hydrolysis are due to the special treatment to which this fibre had been submitted in the course of preparation. The fibre had not been sufficiently washed in clean water after preparation, and still contained some alkali which might be objected to by manufacturers.

The fibre was inferior in colour and lustre to Indian jute of fair quality prepared by retting.

Sida rhombifolia Fibre from South Africa

A small sample of *Sida rhombifolia* fibre from Swaziland, where the plant is known as "vivane," was received at the Imperial Institute early in 1916. It consisted of nearly white, lustrous fibre, well cleaned and prepared, but somewhat harsh. It was of good strength, and about 2 ft. in length.

The sample was too small for the purpose of chemical examination and technical trial.

Fibre of similar quality to this sample, but measuring 4 ft. or more in length, would probably realise a price about £3 or £4 below that of "first native marks" Calcutta jute, which at the date of the report (February 1916) was selling in London at £32 per ton. A small consignment of Sida fibre from India previously examined at the Imperial Institute was sold in London in 1913 at £36 per ton, with "first native marks" Calcutta jute at £35 10*s.* to £36 per ton (see this BULLETIN, 1914, **12**, 36).

The sample from Swaziland was of good quality, but not so fine and silky or so long in staple as the Sida fibre from India referred to above.

In response to a request from the Imperial Institute a larger sample of this fibre was received in June 1916 for detailed examination, technical trial and valuation.

This sample consisted of harsh fibre, mostly matted and gummy, not well-prepared and of little lustre. The material was greyish-cream in colour, with a few small portions of a greyish tinge. Some adherent outer bark was present. The strength was irregular, but on the whole fairly good. The length varied from 2 to 6 ft., being mostly from 3 to 4 ft.

It was examined chemically with the following results compared with a sample of *S. rhombifolia* fibre from India (*loc. cit.*):

	Present sample. *Per cent.*	*S. rhombifolia* from India. *Per cent.*
Moisture	11·6	9·5
Ash	2·3	0·4
α-Hydrolysis, loss	13·2	7·3
β-Hydrolysis, loss	19·6	10·4
Acid purification, loss	5·9	0·8
Loss on washing in water	4·6	—
Cellulose	70·5	75·5

The fibre was valued by brokers at £17 to £18 per ton c.i.f. London, with Calcutta jute at £28 per ton (July 1916). It was considered that such fibre would be saleable for mixing with jute when the latter is obtainable only at high prices.

This fibre appeared to be under-retted and insufficiently washed. It was much inferior in appearance and quality to the small sample from Swaziland previously examined and the sample from India referred to above. In view of the superior appearance of the material previously examined it was recommended that experiments in retting the fibre for varying periods should be carried out, and that the fibre so prepared should be submitted to the Imperial Institute for examination and valuation.

Hibiscus cannabinus Fibre from Rhodesia

A sample of *Hibiscus cannabinus* fibre prepared in Rhodesia, where the plant grows as a weed on cultivated land, was received for examination in January 1916. It consisted of fine, somewhat harsh fibre of fair lustre. The colour was uneven, parts of the sample being pale brown and others light grey, whilst a small proportion was greenish-yellow. The fibre was gummy in parts and had not been well cleaned and prepared. The retting appeared to have been effected somewhat unevenly. The fibre was of irregular strength and the length varied from 4 to 6 ft., being mainly about 5 ft.

The results of chemical examination of the fibre are shown in the following table, compared with a commercial sample of Bimlipatam jute:

	Present sample. *Per cent.*	"Bimlipatam jute." *Per cent.*
Moisture	9·4	12·5
Ash	1·3	1·3
α-Hydrolysis, loss	17·3	11·8
β-Hydrolysis, loss	18·3	15·1
Acid purification, loss	4·9	—
Loss on washing in water	2·6	—
Cellulose	71·2	75·4

The sample was valued by merchants in London at about £27 per ton (May 1916), with "First Marks" Calcutta jute at £32 per ton.

The comparatively large losses on hydrolysis, acid purification and on washing in water, together with the low percentage of cellulose, show that this sample was

of somewhat poor quality owing to imperfect retting and washing. The fibre was inferior in colour, softness and general appearance to fair quality "Bimlipatam jute," which is prepared from *H. cannabinus* in India, and usually realises a price about £2 to £3 per ton below that of "First Marks" Calcutta jute.

The firm who valued the sample stated that the fibre should be quite suitable for mixing with the lower grades of Calcutta jute, and that if it were better prepared it should find a good market in the United Kingdom.

In this connection it must be borne in mind that the price quoted above for "First Marks" Calcutta jute is abnormally high owing to the war, the price in normal times being only £15 to £20 per ton. The price of this Hibiscus fibre under normal conditions would, of course, be correspondingly reduced.

The poor quality of this sample, and of previous samples of *Hibiscus* fibre from Rhodesia (cf. this BULLETIN, 1915, **13**, 22), appears to be due to lack of experience of the methods of preparation. The present sample was of uneven quality and colour, parts being gummy and obviously under-retted. To obtain the best results the progress of the retting action should be observed from time to time by removing a few stems from different parts of the pile and testing the ease with which the fibre ribbons may be separated from the stems and from adherent bark. It is essential also that care should be taken throughout to keep the fibres from becoming tangled.

Hibiscus cannabinus Fibre from Egypt

A sample of *Hibiscus cannabinus* fibre prepared from the native "til" plant by a special process was received in August 1916. The fibre was of a buff colour, clean and well prepared. It was fairly soft, but showed some red stains, and was practically devoid of lustre. It was of fairly good strength and varied in length from 2 ft. 6 in. to 5 ft. 6 in., being mostly from 3 ft. to 3 ft. 6 in.

The fibre was examined chemically with the following results, compared with *H. cannabinus* fibre from Rhodesia and "extra fine" Indian jute :

	Present sample.	*H. cannabinus* from Rhodesia.	"Extra fine" Indian jute.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	8·5	9·6	9·6
Ash	1·6	1·2	0·7
α-Hydrolysis, loss	6·1	11·6	9·1
β-Hydrolysis, loss	9·3	15·2	13·1
Acid purification, loss	2·7	0·8	—
Loss on washing in water	2·0[1]	—	—
Cellulose	79·9	74·3	77·7

[1] *Including 1 per cent. of alkali expressed as sodium carbonate* (Na_2CO_3).

The fibre was valued by brokers in London at about £30 per ton, c.i.f. London, with Calcutta jute at £41 and "Bimlipatam jute" (*H. cannabinus*) at £35 per ton (December 1916).

The low figures for loss on hydrolysis and the high percentage of cellulose are due to the special treatment to which this fibre had been submitted in the course of preparation. The fibre had not been sufficiently washed, and contained alkali.

The fibre was inferior in appearance, and especially in lustre, to well-prepared Hibiscus fibre obtained by retting.

Hibiscus Fibre from Nyasaland

Two samples of Hibiscus fibre prepared from wild plants were received from Nyasaland in November 1915. They were examined with the following results:

No. 1.—This sample consisted of rather harsh fibre, of poor lustre, and varying in colour from cream to pale reddish-brown. The material was clean and fairly well prepared on the whole, but rather gummy in parts. It was of very good strength, and was mostly from 2 to 3 ft. in length, but some shorter fibre was also present.

The fibre was examined with the following results compared with Hibiscus fibre from the Sudan and "extra fine" Indian jute:

	Present sample.	Hibiscus fibre from the Sudan.	"Extra fine" Indian jute.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	10·8	8·2	9·6
Ash	3·2	0·7	0·7
α-Hydrolysis, loss	17·9	8·6	9·1
β-Hydrolysis, loss	21·7	13·4	13·1
Acid purification, loss	8·0	—	—
Loss on washing in water	3·6	—	—
Cellulose	71·6	77·8	77·7

The material was valued at £37 per ton, c.i.f. London (September 1916), with medium quality Indian jute ("first native marks") at £33 to £34, finest Indian jute ("Green D") at £45, and "Bimlipatam jute" (*Hibiscus cannabinus*) at about £27 per ton.

No. 2.—This fibre was reddish-brown in colour, harsh, and practically devoid of lustre. It was not well prepared, being gummy and containing some adherent bark. The ends had the appearance of having been cut. It was of uneven strength, and very weak in parts. The length was mostly between 2 and 3 ft., with a fair proportion of shorter fibre.

The fibre gave the following results on chemical examination compared with Hibiscus fibre from the Sudan and "extra fine" Indian jute:

	Present sample.	Hibiscus fibre from the Sudan.	"Extra fine" Indian jute.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	10·3	8·2	9·6
Ash	2·6	0·7	0·7
α-Hydrolysis	16·2	8·6	9·1
β-Hydrolysis, loss	22·1	13·4	13·1
Acid purification, loss	6·7	—	—
Loss on washing in water	7·6	—	—
Cellulose	68·8	77·8	77·7

This sample was valued at £30 per ton, c.i.f. London (September 1916). The prices of Indian and Bimlipatam jutes on this date are given above.

In the case of both these samples the losses on acid purification, hydrolysis and washing in water were high, and the amount of cellulose in the fibre was low. The material had apparently been insufficiently cleaned and prepared. Sample No. 2 was distinctly inferior to No. 1, especially in strength, and the poor strength of parts of the former fibre suggests that the fibre had been damaged by being baled in a moist condition.

Nettle Fibre from India

The sample of nettle fibre from India which is the subject of this report was forwarded to the Imperial Institute by the Fibre Expert to the Government of Bengal in March 1916.

The sample consisted of uneven, very tangled fibre, varying in colour from brown to pale buff with many green portions. The fibre, which was stated to have been prepared merely by mechanical treatment, retained most of the gummy matter, and was coated with bark. The length of staple varied from 3 to 5 ft., but was mostly about 3 ft. 6 in. The individual fibres were very fine in diameter, and appeared to be weaker than either flax or ramie.

A portion of the sample was cleaned and degummed at the Imperial Institute. The cleaned fibre was moderately lustrous, and was found to be made up of ultimate fibres measuring mostly from 4 to 5 in. in length and from about 0·002 to 0·004 in. in diameter. The fibre was thus similar to ramie and certain other nettle fibres.

Samples of the crude fibre as received, and of the cleaned and degummed material, were submitted to brokers in London and Dundee, who reported on them as follows:

(1) The London brokers stated that nettle fibre of this kind would in any case require to be properly degummed before being used as a substitute either for flax or ramie, and that this would add considerably to the cost of production. They pointed out, moreover, that the fibre was brittle and of irregular strength, being weaker than flax and very considerably weaker than ramie. The firm were therefore of opinion that the material would hardly be a suitable substitute for either flax or ramie, but that it would be more suitable for mixing with jute if it could be prepared at a sufficiently low price. They regarded the cleaned, degummed fibre as worth probably from £35 to £40 per ton in London (June 1916).

(2) The Dundee brokers reported that the material in the uncleaned state could only be used for a heavy jute rove, and that its value in that condition would not exceed £15 per ton. They considered that the cleaned and degummed fibre could be used for similar purposes to the lower qualities of Italian hemps, but that it would not have sufficient spinning quality to be used as a flax substitute. The firm valued the cleaned and degummed fibre at from £26 to £30 per ton (June 1916).

This fibre in the crude state would almost certainly

be unsaleable, owing to its gummy condition and the presence of bark; but, if it were possible to prepare the fibre in India in a clean condition by retting, there seems to be no reason why it should not be used in admixture with jute or hemp for the manufacture of coarse textiles. If, however, it is not found possible to ret the fibre in India it might perhaps be saleable in the form of clean bark ribbons, if the outer bark could be removed by scraping in a manner similar to that by which China grass (ramie) ribbons are prepared for the European market.

Sisal Hemp from Rhodesia

The sample of Sisal hemp dealt with in this report was prepared from plants grown at the Experimental Gardens, Chilanga, Northern Rhodesia. The Sisal was planted in April 1913 and the leaves decorticated by hand in May 1916. So far, the fibre has not been produced on a commercial scale in Rhodesia.

The sample, which was received at the Imperial Institute in January 1917, consisted of lustrous fibre, of pale cream colour, and very well cleaned and prepared. It was of very good strength and varied in length from 2 ft. to 3 ft. 4 in., being mostly from 2 ft. 6 in. to 3 ft.

The fibre was submitted to chemical examination, with the following results, compared with Sisal hemp from East Africa:

	Present sample.	Sisal hemp from East Africa.
	Per cent.	*Per cent.*
Moisture	7·4	9·5
Ash	0·6	0·8
α-Hydrolysis, loss	9·3	11·3
β-Hydrolysis, loss	11·7	14·8
Acid purification, loss	1·1	2·1
Loss on washing in water	1·3	—
Cellulose	80·5	77·4

The fibre was valued at £65 per ton in London (February 1917) with British East African Sisal at £67 to £70 per ton.

This fibre was of exceptionally good quality, and was stated by the brokers to whom it was submitted for valuation to be one of the best-prepared samples of Sisal hemp they had seen. It was stated that a slightly greater

length of staple would enhance the value of the fibre to the extent of from £2 to £3 per ton.

Furcræa Fibre from Southern Rhodesia

The sample of Furcræa fibre from Southern Rhodesia dealt with in this report was received at the Imperial Institute in June 1915. It consisted of moderately lustrous fibre, fairly well cleaned and prepared, and varying in colour from cream to pale buff. A fair proportion of adherent pith was present in the sample. The strength was fairly good, but rather uneven, and the length varied from 3 to 8 ft., being mostly from 5 ft. to 5 ft. 6 in.

The fibre was examined chemically with the following results, compared with previous samples of Furcræa fibre from Rhodesia (see this Bulletin, 1915, **13**, 21):

	Present sample.	Previous samples from Rhodesia.	
	Per cent.	*Per cent.*	*Per cent.*
Moisture	10·1	11·5	10·1
Ash	1·6	1·5	1·4
α-Hydrolysis, loss	14·8	12·7	14·0
β-Hydrolysis, loss	17·8	17·7	16·4
Acid purification, loss	4·4	0·4	1·7
Cellulose	72·0	79·3	77·6

The sample was valued at about £34 to £35 per ton in London (July 1915) by merchants, who stated that similar material would be saleable in large quantities.

The results of the chemical examination show that this sample was inferior to the Furcræa fibre from Rhodesia previously examined at the Imperial Institute, on account of the somewhat greater losses on hydrolysis and acid purification, aud the lower percentage of cellulose. The rather high losses on acid purification and hydrolysis indicate that the fibre had not been sufficiently washed.

Fibre of better quality could be obtained by more thorough washing and removal of the pith by brushing, and also by sorting into bundles of uniform length. It was also suggested that efforts should be made to obtain the fibre as nearly white as possible.

The fibre, it may be mentioned, was considerably coarser than the Furcræa fibre (*Furcraea gigantea*) produced in Mauritius.

Furcraea gigantea Fibre from South Africa

A sample of *Furcraea gigantea* fibre from Winkle Spruit Experimental Farm was received at the Imperial Institute in September 1915. The fibre was of dull appearance, and cream to very pale buff in colour. It was insufficiently cleaned and prepared, a quantity of pith, leaf epidermis and gummy matter being present. It was of good strength, and varied in length from 5 ft. to 7 ft. 6 in., being mostly about 6 ft. It gave the following results on chemical examination :

	Per cent.
Moisture	9·9
Ash	1·3
α-Hydrolysis, loss	13·8
β-Hydrolysis, loss	16·3
Acid purification, loss	2·8
Cellulose	72·7

The material was submitted to a firm of merchants, who valued it at £20 to £21 per ton, c.i.f. London (October 1915), adding that, if well cleaned and prepared, it would probably have been worth £32 to £33 per ton.

This fibre was well grown and of good length and strength, but, as the results of examination show, it had been badly cleaned and prepared. Consignments represented by the present sample would not be very saleable on the London market. By more thorough cleaning, however, the fibre could be obtained free from extraneous matter and of greatly improved lustre and general appearance, and it would then find a ready market.

Asclepias fruticosa Fibre from South Africa

According to the Chief of the Division of Botany, Union Department of Agriculture, *Asclepias fruticosa*, which is known locally as "melkbosch" and is common and widely distributed throughout South Africa, is especially abundant in the neighbourhood of Pretoria and Johannesburg, and large quantities could be collected if necessary.

Two samples of fibre prepared from the stems of this plant were received at the Imperial Institute from South Africa in November 1915. Information was requested as to

whether these fibres, which are non-lignified, possess any special value for the manufacture of explosives.

Both samples of fibre were prepared at the Botanical Laboratories, Pretoria, No. 1 being obtained from plants collected in August and No. 2 from plants collected in October when in flower.

No. 1.—This consisted of rather harsh fibre of poor lustre, nearly white with a greenish tinge. The fibre was clean but not well prepared, a good deal of bark being present. The strength was fair. The length of the staple varied from 14 to 30 in., being mostly from 21 to 22 in.

No. 2.—This sample closely resembled No. 1 in general appearance. The length of staple varied from 16 to 26 in. and was mostly about 20 in.

The samples were submitted to chemical examination with the following results:

	No. 1. *Per cent.*	No. 2. *Per cent.*
Moisture	8·0	8·4
Ash	1·5	1·4
α-Hydrolysis, loss	13·1	13·0
β-Hydrolysis, loss	16·2	15·4
Acid purification, loss	7·0	7·0
Cellulose	82·0	81·5
Gain on nitration	51·5	53·5

The richness of this Asclepias fibre in cellulose and the large increase of weight on nitration confirmed the results of previous investigations of this variety of fibre at the Imperial Institute, and indicated that the material might be useful for the manufacture of explosives (cf. this BULLETIN, 1905, **3**, 316, and *Selected Reports from the Scientific and Technical Department, Imperial Institute, Part I, Fibres, Colonial Reports, Misc. Ser.*, No. 58 [Cd. 4588, 1909], p. 50).

The samples were submitted for valuation to a firm of merchants in London, who valued No. 1 at £37 to £38 and No. 2 at £32 to £33 per ton (March 1915). They based this valuation on a comparison with Sisal hemp which, if not less than 3½ to 4 ft. in length, at that date realised about £50 per ton.

The firm added that it was not advisable to cut any fibre plants under 3 to 3½ ft. in length, as spinners of hard fibres object to using any material measuring under 3 ft.

The firm also expressed a wish to take charge of any consignment of this Asclepias fibre which may be shipped to the United Kingdom. The Imperial Institute has asked the Union Government as to the prospects of the material being exported in commercial quantities and for the names and addresses of possible exporters, but this information has not yet been received.

Kapok from the Sudan

A sample of kapok obtained from trees planted some years ago at Mongalla, Sudan, was received at the Imperial Institute in December 1916.

The sample consisted of clean, soft, lustrous, resilient kapok of cream colour. A small proportion of pieces of the inner part of the pods was present. The fibre was of normal strength for kapok, and had a length of staple of from 0·7 to 1·0 in.; the diameter varied from 0·0007 to 0·0012 in.

A sample of the material cleaned and freed from extraneous matter at the Imperial Institute was submitted to brokers in London, who stated that the floss had a resiliency equal to that of Java kapok. They assigned a nominal value to the material of 1*s.* per lb. on spot (January 1917).

This floss was of excellent quality, and similar material, if shipped clean and free from extraneous matter, should realise the current market price of good quality kapok, for which there is a large demand at present.

Kapok from Togoland

Kapok received special attention from the late German authorities in Togoland, and seed was distributed to the natives in large quantities, especially in the districts of Sokode-Bassari, Kete-Kratschi and Mangu. In 1913, 9 tons of kapok, valued at £472, were exported.

A small bale of kapok from Togoland was received at the Imperial Institute from the Chief Commissioner, Northern Territories, Gold Coast, in August 1916. The material consisted of very soft, lustrous, resilient fibre of a dark cream colour. It was similar in all respects to the

kapok of commerce (*Eriodendron anfractuosum*), which is mainly imported from Java.

The diameter of the fibres varied from 0·0007 to 0·0010 in., being mostly 0·0008 in., and the length of staple varied from 0·7 to 1·0 in. The fibres were weak, but of normal strength for kapok.

The kapok was submitted to a firm of brokers for sale on behalf of the Imperial Institute. The best offer received was *7d.* per lb., and the bale was accordingly sold at this price in London (October 1916).

There is little doubt that consignments of kapok of this quality would always be readily saleable in the United Kingdom at good prices. The price of *7d.* per lb. obtained for the present consignment may be regarded as satisfactory, but it would probably have been higher if the quantity of material had not been so small.

As there is a ready market for this material in London for upholstery and other purposes, it seems desirable that an effort should be made to develop the industry in Togoland. Large quantities of kapok are now being used for the manufacture of life-buoys and life-saving jackets and mattresses, but for these purposes the Board of Trade regulations specify that *Java* kapok should be employed. It was suggested to the Gold Coast authorities that if fairly large supplies of kapok from Togoland are likely to be available, a sample should be forwarded to the Imperial Institute, in order to ascertain whether it complies sufficiently with the Board of Trade requirements to be acceptable as a substitute for the Java product. Information has also been requested as to the quantity of kapok now available for sale, and the amounts likely to be available in the near future.

It was further pointed out that it would be advisable to have the remainder of the kapok now available shipped to the United Kingdom for sale, and to encourage the natives to collect and clean further quantities for export.

A few years ago, it was reported that the Germans had introduced machinery into Togoland for freeing kapok from the seeds, but so far no information is available as to how the present consignment was cleaned, whether by machinery

or by some primitive native method. According to the Report of the German Colonial Office on Togoland for 1912–13, attempts to gin the product by machinery had not up to then given satisfactory results.

Asclepias fruticosa Floss from South Africa

An account of the results of examination at the Imperial Institute of the floss of *A. fruticosa* from the Transvaal was given in this Bulletin (1913, **11**, 81). A further sample was received in June 1916. It consisted of clean, very soft and lustrous floss varying in tint from pale yellow to cream. The material was inferior to kapok in resiliency.

The fibres of the floss measured from 0·6 to 0·9 in. in length, with a diameter of from 0·0005 to 0·0011 in. The strength was fairly good with regard to longitudinal stress, but the fibres were somewhat brittle, as is usually the case with such products. Microscopical examination showed that the fibres were quite smooth, and had very thin walls with a wide channel in the centre.

Samples of the floss were submitted to a firm of brokers and to manufacturers of upholstery materials, who reported as follows:

(*a*) The brokers regarded the material as similar to the floss known in commerce as "Akund." They stated that there is only a limited consumption of the product in the United Kingdom, where kapok is preferred, and that before the war most of the "Akund" went to Germany. The firm considered the nominal value of the material to be about 5½*d.* or possibly 6*d.* per lb. in London (July 1916).

(*b*) The manufacturers stated that the floss was of low quality and that there would be less demand for it than for kapok. They valued the material, if marketed free from seed like the sample submitted to them, at from £25 to £30 per ton (*i.e.* about 2¾*d.* to 3¼*d.* per lb.), c.i.f. London (July 1916).

As already stated, there has recently been a large demand for kapok for use in stuffing life-belts and other life-saving devices. A sample of this floss was therefore submitted to a manufacturer of such appliances. He stated that the material generally resembled akund, kapok and bombax

floss, but on preliminary examination appeared to be much inferior to them in buoyancy. It is desirable, however, to make further trials of the material, and for this purpose a large sample of the floss has been requested.

Seed Hairs of *Ipomoea albivenia* from South Africa

Ipomoea albivenia, Sweet, is an evergreen climber belonging to the Natural Order Convolvulaceæ, and is closely allied to the sweet potato. A sample of the seed hairs of this plant was forwarded to the Imperial Institute by the Trades Commissioner for the Union of South Africa in August 1916. It was stated that large quantities of the material were understood to be available in Natal and Zululand, and could be collected cheaply by natives. The product is known locally as Kaffir or Natal cotton.

The sample consisted of seed with adherent hairs of dark cream colour, resembling harsh, unginned cotton. The fibres had little lustre, and were weak and brittle.

The seeds, which were easily separated from the seed hairs, were devoid of adherent fuzz, and were of a pale brown colour. They were triangular in cross section, and measured about 0·3 in. in length.

The yield of seed hairs on ginning the material was 31 per cent., the yield per 100 seeds being 4·6 grams.

The fibres measured 0·0009 to 0·0023 in. in diameter, with an average of 0·0015 in. Cotton has a diameter of 0·0004 to 0·0011 in. with an average of 0·0008 in. The length of staple varied from 0·6 to 1·4 in., being mostly from 1·0 to 1·1 in. Microscopical examination showed that the fibres were somewhat similar in general appearance to those of cotton, but they were thin-walled and were not generally twisted as is the case with cotton.

Comparative tests showed that the raw Ipomœa fibre was much more absorbent than untreated cotton, but less so than prepared "absorbent cotton wool," and that after being bleached it was still slightly less absorbent than the latter material. The following table gives the number of grams of water absorbed by 1 gram of the material in each case:

	Cotton wool. *Grams.*	Seed hairs of *Ipomoea albivenia.* *Grams.*
Unbleached	3·5	16
Bleached, absorbent . .	24[1]	21

[1] *The material used for this test was "absorbent cotton wool," such as is used for surgical dressings.*

The seed hairs of *I. albivenia* would probably be unsuitable for spinning, as the fibres lack the twist characteristic of cotton, and are very weak. The weakness of the fibres would probably cause difficulty in "carding," and the fibre would yield yarn of poor strength.

If obtainable in large enough quantities at a low price the seed hairs might possibly be of use as a stuffing material in upholstery. The material is, however, much less resilient than kapok, and would therefore be less valuable.

These seed hairs might find an outlet for the production of nitro-cellulose, but experiments made at the Imperial Institute on a previous sample of the material showed that it contained much less cellulose than cotton (77·3 against 95 to 96·5 per cent.), and it would therefore be inferior to cotton for this purpose.

The raw fibre would not be sufficiently absorbent for use in surgical swabs, and the chemical and mechanical methods usually employed in preparing cotton for this purpose would cause a good deal of waste, and the product would be much inferior to absorbent cotton.

On the whole this is not a promising material. The sample now reported on was, however, too small for detailed investigation, and a larger sample has been asked for in order to investigate fully its value for some of the purposes suggested above.

COTTON CULTIVATION IN AUSTRALIA

THE climatic conditions of large areas in the warmer parts of Australia are well adapted for the growth of cotton. At the present time, however, it is cultivated to only a small extent in Queensland and the Northern Territory. The chief difficulty is the high cost of picking, due partly to inexperience, but mainly to the high rate of wages. It is thought that the labour difficulty might be overcome by growing the crop in small areas only, say about 10 acres

each, which could be picked by a family of four persons without extra help. Efforts have also been made to obtain a satisfactory cotton-picking machine, but so far without success. Black labour (aboriginal) is employed only on one estate, in North Queensland, where the crop is grown on the plantation system; elsewhere cotton is cultivated as a subsidiary crop by white labour in areas varying from 5 to 30 acres.

Cotton was first grown in Queensland in 1852, in which year 70 bales and 18 bags were shipped to England. At the time of the American civil war, and for a few years afterwards, when cotton prices in England were very high, a large area was cultivated in Queensland, the maximum export being 2,500,000 lb. of ginned cotton in 1871. The increase in American production after the war led to a fall in price to the normal level, and the Queensland industry practically died out. An attempt to revive it was made in 1890, when a cotton mill was started at Ipswich, but this closed in 1897, when cotton-growing ceased. A few years later the Government imported seed from America and Egypt, and distributed it free to growers with a view to encouraging cultivation, but the area devoted to the crop since then has never been large, the maximum during the ten years 1906-1915 being 605 acres in 1911, when the production amounted to 186,894 lb., valued at £4,672. By 1915 the area had fallen to 72 acres, and the production to 12,238 lb., of value £306. In 1913 the British Cotton Growing Association agreed to assist the industry by making a grant, by provision of seed for experiment, by undertaking the sale of the cotton and guaranteeing a minimum price of 6½*d.* per lb. for all annual-grown cotton. More recently a Munitions Cotton League was formed in Queensland to stimulate the production of cotton, particularly for the manufacture of explosives. The Government distributed seed to 300 farmers and guaranteed to purchase seed-cotton at 1¾*d.* per lb. As a result 800 acres were planted in 1916. Sufficient American cotton seed is being imported to plant an additional area of 1,000 acres next season.

Of the other parts of Australia, the Northern Territory grows very little cotton, 15 acres being under the crop in

1912-13; parts of Western Australia and New South Wales are also suitable for the crop, but so far it has not been produced on a commercial scale.

Samples of cotton grown in Queensland, Western Australia and New South Wales have been received at the Imperial Institute in recent years, and the results of their examination are given in the following pages.

Queensland

One sample of cotton was received from Queensland in 1911 and two further samples in 1912. The two later samples were grown from Egyptian seed and represented the first year's crop—that is, the plants had not been acclimatised.

No. 1.—The variety of this cotton was not stated. The lint was clean, fairly lustrous, slightly harsh, white and free from stains; the yield on ginning was 34·15 per cent. and the yield per 100 seeds 7·0 grams. The seeds were fairly large, smooth and brown, each bearing a tuft of down and a spike at the pointed end.

The cotton was of poor strength and varied in length from 0·7 to 1·3 in., being mostly from 0·9 to 1·1 in.

The ginned material was valued at from 6·80*d.* to 6·90*d.* per lb., with "middling" American at 6·46*d.* per lb.

This cotton was of good colour, rather harsh and coarse, and decidedly weak. It was classed by brokers as of "barely good middling" grade.

No. 2.—This was stated to be an Egyptian variety, probably "Afifi." The lint was clean, soft and fine, of fairly good lustre and of rather irregular colour, varying from very pale reddish-brown to almost white, with a few dark brown or yellowish stains. The yield of lint on ginning was about 19·4 per cent. and the yield per 100 seeds about 2·52 grams. The seeds were of medium size and of dark chocolate colour, almost black. A few seeds had a small tuft of white or green fuzz at the pointed end.

The strength of this cotton was fairly good, but the length was rather irregular, ranging from 1·1 to 2·1 in.

The ginned cotton was valued at 12·50*d.* per lb., with "choice" Georgia Sea Island cotton at 13*d.* per lb. and "fancy" Florida Sea Island at 14*d.* per lb.

This cotton did not possess the characters of Egyptian Mitafifi, but resembled the Sea Island variety. It was of satisfactory quality apart from its rather uneven colour and irregular length. These defects could probably be remedied by seed selection and greater care in cultivation.

No. 3. "*Nubari.*"—The lint of this sample was clean, soft and fine, of moderately good lustre, but of uneven colour, varying from pale reddish-brown to cream, with occasional rusty-brown stains. The yield of lint on ginning was about 27·5 per cent. and the yield per 100 seeds about 4·01 grams. The seeds were of medium size and mostly of dark chocolate colour, with a small tuft of white fuzz at the pointed end. Several seeds bore patches of white fuzz, and many yellow or partly yellow unripe seeds were present.

This cotton was of poor strength, much immature fibre being present. The length varied from 1·1 to 1·7 in. and was mostly from 1·3 to 1·5 in. Short weak fibres were also present.

The ginned cotton was valued at 9·25*d.* per lb., with "good fair" brown Egyptian at 9·80*d.* per lb. and "good fair" Nubari at 10·20*d.* per lb.

This cotton was inferior to ordinary Egyptian Nubari in length and strength, but would nevertheless be readily saleable. Some of the cotton did not seem to have ripened properly, and in consequence a good deal of short weak fibre was present which would cause waste in manufacture.

As in the case of sample No. 2, this cotton could be improved by careful methods of cultivation and seed selection.

Western Australia

Two samples of seed-cotton produced experimentally in Western Australia were received in April 1912.

No. 1. "*Durango.*"—The lint of this sample was clean, lustrous, soft, white, and free from stains. The yield of lint on ginning was about 40 per cent. and the yield per 100 seeds about 7·9 grams.

The seeds were of medium size and coated with a brownish fuzz.

This cotton was of rather poor strength and its length varied from 0·9 to 1·5 in., being mostly from 1·2 to 1·4 in.

The fibres had a diameter of from 0·0006 to 0·0010 in., the average being 0·00076 in.; they exhibited a good twist and were fully mature.

The ginned cotton was valued in Liverpool at 9·00*d.* per lb., with "middling" American at 6·37*d.* per lb. and "good" Egyptian Abassi at 11*d.* per lb.

This cotton was of an improved American type and of excellent quality. The yield of lint on ginning was higher than is usual for this kind of cotton.

No. 2. "*Sea Island Cotton.*"—The lint in this sample was clean, fairly lustrous, soft, of pale cream colour and free from stains. The yield of lint on ginning was about 32·5 per cent., the yield per 100 seeds being about 5·4 grams.

The seeds were of medium size, mostly dark brown and tufted with down at the pointed end, a few being completely covered with a brownish fuzz. It may be mentioned that pure Sea Island cotton seed is free from down or fuzz.

The strength of the cotton was rather poor and somewhat irregular. The length varied from 1·0 to 1·9 in. and was mostly from 1·5 to 1·7 in. The diameter of the fibres ranged from 0·0006 to 0·0011 in., the average being 0·00081 in. The average diameter of Sea Island cotton is usually about 0·00064 in. Most of the fibres showed a good twist and were fully mature.

The ginned cotton was valued in Liverpool at 13*d.* per lb., with "choice" Georgia Sea Island at 12½*d.* per lb. and "extra fine" Sea Island at 19½*d.* per lb.

This cotton differed a good deal from ordinary Sea Island cotton, being very much coarser, but such cotton, if produced in commercial quantities, should be readily saleable.

Three further samples of seed-cotton were received for examination in July 1914. They were stated to have been grown under natural conditions without irrigation, on two-year-old trees, at Derby, in the north-western portion of Western Australia.

No. 3. "*Russell.*"—The lint of this sample was clean, rather harsh, lustrous, white, almost free from stains, but slightly "leafy." The seeds were large, covered with long, white, brownish or greenish fuzz; some of the seeds had been attacked by insects.

The cotton was of fairly good strength and varied in length from 0·6 to 1·2 in., being mostly from 0·8 to 1·0 in.

The ginned cotton was valued at from 5·91*d.* to 6·16*d.* per lb., with "middling American futures" at 6·12*d.* per lb.

This cotton was rather shorter and harsher than is usual for cotton of the Russell variety.

No. 4. *Long Stapled* (*Upland*).—The lint was clean, fairly soft, lustrous and pale cream-coloured; it showed occasional yellowish-brown stains and was slightly "leafy." The seeds were large and covered with long greyish or greenish fuzz; many had been attacked by insects.

The cotton was of fair strength and varied in length from 1·0 to 1·6 in., being mostly from 1·3 to 1·5 in.

The ginned cotton was valued at from 6·66*d.* to 6·91*d.* per lb., with "middling American futures" at 6·12*d.* per lb.

This cotton was of satisfactory quality, but was rather weaker than ordinary American cotton and slightly stained.

No. 5. "*Sunflower.*"—The lint of this sample was clean, soft, lustrous and white; a few yellowish-brown stains were present. The seeds were large and mostly covered with white or brownish fuzz, but some brown seeds without fuzz were also present; many of the seeds had been attacked by insects.

The strength of the cotton was a little irregular, but on the whole was fairly good. The length varied from 1·0 to 1·6 in., being mostly from 1·2 to 1·4 in.

The ginned cotton was valued at 6·91*d.* per lb., with "middling American futures" at 6·12*d.* per lb.

This cotton was a little deficient in strength, but was regarded by commercial experts as of better quality than Nos. 3 and 4.

A large proportion of the seeds of Nos. 3 and 5 had been attacked. One or more living larvæ were found in each sample, and these were identified as *Gelechia gossypiella*, the pink boll-worm, an insect which has caused considerable damage in Egypt. It is of great importance that measures should be taken to destroy this pest, and an account of the most suitable methods will be found in this BULLETIN (1914, **12**, 312).

New South Wales

Cotton-growing experiments were conducted in New South Wales in 1914, when seed of different varieties was distributed by the Department of Agriculture to farmers in various parts of the State, and the crop was grown under irrigation at the Department's Experiment Farm at Yanco. The best results obtained, so far as yield is concerned, were with the "Russell's Big Boll" variety, grown from Queensland seed, which gave a yield of 620 lb. of seed-cotton per acre. Specimens of cotton grown at the Yanco Experiment Farm and also by private farmers were received for examination at the Imperial Institute in March 1916.

No. 1. "*Russell's Big Boll.*"—Grown at Nimbin. This sample consisted of bolls and seed-cotton. The bolls were well grown and evenly developed.

The lint was cream-coloured, fairly lustrous and soft, with some broken leaf and husk and some immature and stained fibre. The yield of lint from the seed-cotton on ginning was 34·2 per cent. and the yield per 100 seeds 6·9 grams.

The seeds were large and mostly covered with long greyish fuzz, but some seeds bore bright green fuzz and some smooth black seeds were also present.

The strength was uneven but good on the whole, and the length varied from 0·9 to 1·1 in.

The ginned cotton was valued at 8·75*d.* per lb.

This cotton was slightly stained, but otherwise of very satisfactory quality.

No. 2. "*Russell's Big Boll.*"—Grown at Yanco Experiment Farm. This was a sample of unginned cotton.

The lint was cream-coloured, lustrous, fairly soft and free from leaf and immature fibre. The sample gave a yield of 33·0 per cent. of lint on ginning, the yield per 100 seeds being 5·8 grams.

The seeds were large and mostly covered with long green fuzz, but in some cases with brown fuzz.

The cotton was of good strength and varied in length from 0·8 to 1·2 in.

The ginned cotton was valued at 8·50*d.* per lb.

This cotton was of very good quality, but a little less regular in length than sample No. 1.

No. 3. "*Russell's Big Boll.*"—Grown at Blacktown. This consisted of bolls which were well grown and evenly developed.

The lint was cream-coloured, fairly soft and lustrous, and practically free from immature fibre. The yield of lint from the seed-cotton on ginning was 36·0 per cent. and the yield per 100 seeds 7·5 grams.

The seeds were large and covered with long greyish-brown or green fuzz.

The strength of the cotton was irregular, but good on the whole. The length varied from 0·9 to 1·1 in.

The ginned cotton was valued at 9·00*d.* per lb.

This cotton was of even length and excellent appearance.

No. 4. "*Durango.*"—Grown at Yanco Experiment Farm. This was a sample of unginned cotton.

The lint was cream-coloured, soft, clean, lustrous and free from stains, but contained a little immature fibre. The yield of lint on ginning was 33·1 per cent. and the yield per 100 seeds 5·1 grams.

The seeds were large and mostly covered with long white fuzz, but in some cases with greenish fuzz.

This cotton was of irregular strength, some portions being of excellent strength and others rather weak. It varied in length from 0·8 to 1·2 in., but mostly from 1·1 to 1·2 in.

The ginned cotton was valued at 10·50*d.* per lb.

This cotton was a little longer than the preceding samples, and was therefore regarded as more valuable.

No. 5. "*Allen's Long Staple.*"—Grown at Narromine. This also consisted of unginned cotton.

The lint was cream-coloured, soft, clean and lustrous. The sample gave a yield of 27·6 per cent. of lint on ginning, the yield per 100 seeds being 3·1 grams.

The seeds were of medium size, and covered with long fuzz, in most cases white, but in a few cases green or grey in colour.

The strength of the cotton was mostly good, but partly soft and rather weak. The length varied from 0·8 to 1·2 in., but was mostly from 1·0 to 1·1 in.

The ginned cotton was valued at 9·50*d.* per lb.

The staple in this sample was shorter than is usual for Allen's Long Staple cotton, which generally has a length of about 1·5 in.

No. 6.—Grown at Pooncarie. The sample was described as "Allen's Long Staple," but was evidently not that variety. It was very mixed, and its identity is doubtful. It consisted of both ginned and unginned cotton.

The lint was fairly soft, with a brownish tint and rather dull appearance. The yield of lint on ginning was 32·4 per cent. and the yield per 100 seeds was 6·2 grams.

The seeds were large, smooth and black, with a small tuft of green fuzz at each end.

The strength of the cotton was somewhat uneven, but on the whole good. The length varied from 0·9 to 1·9 in., being mostly from 1·0 to 1·5 in.

The sample was too small and mixed for valuation.

This cotton somewhat resembled Egyptian Mitafifi, both in the colour and appearance of the lint and in the smooth, green-tufted seeds; but it was obviously of mixed staple.

No. 7.—Grown at Casino. This sample was described as "Allen's Long Staple," but the accuracy of this identification seems doubtful (see below). It consisted of bolls which were well grown and evenly developed.

The lint was lustrous, soft, clean, nearly white and free from immature fibre. The yield of lint from the seed-cotton on ginning was 34·4 per cent., the yield per 100 seeds being 7·2 grams.

The seeds were large and covered with long greyish-brown or green fuzz.

This cotton was of good strength and the length ranged from 0·8 to 1·2 in., being mostly from 1·0 to 1·1 in.

The sample was too small for valuation, but in general appearance and quality it closely resembled sample 2, and would probably realise about the same price.

The cotton appeared to resemble "Russell's Big Boll" rather than "Allen's Long Staple," both in the size and appearance of the seed and in the length of staple.

On the whole, these cottons from New South Wales were of good quality, and, if the yield per acre is satis-

factory, the cultivation appears very promising and should be encouraged. It may be mentioned that, at the present time, there is a scarcity of long-stapled cotton in the markets of the United Kingdom, and the value therefore rises rapidly as the length increases, cotton of a length of 1·2 to 1·3 in. being valued at 2*d.* or 3*d.* per lb. in advance of cotton of 1·0 in. For comparison with the valuations given above of these cottons from New South Wales, it may be mentioned that "good middling" American cotton was worth 8·00*d.* per lb. on the same date.

TOBACCO FROM NORTHERN PROVINCES, NIGERIA

Tobacco is grown for native use in almost every part of the Northern Provinces, Nigeria. The crop is carefully cultivated and manured, but the method of curing is very primitive and the product is quite unfit for export. In 1915 experiments were inaugurated by the Agricultural Department with the object of producing a "bright" tobacco of the Virginian type. Seed of well-known American varieties was obtained from the Department of Agriculture, Union of South Africa, and trials were started at Maigana and Ilorin Experiment Stations. The extreme dryness of the air at the former station made it difficult to handle the crop successfully, but at Ilorin the results were distinctly promising.

Four samples of tobacco produced in the experiments at Ilorin were received for examination in June 1916. According to information supplied by the Director of Agriculture, the soil on which the crop was raised consisted of a light sandy loam, rather deficient in plant food, having been cropped with maize and yams in successive years. A crop of cow-peas was grown on the land in the earlier part of the year, and was dug in as green manure one month before the tobacco seedlings were transplanted. The land was also manured with town refuse at the rate of approximately 2 tons per acre. On account of the dry season supervening the plants ripened somewhat prematurely, thus preventing the full development of the leaf.

The tobacco was cured partly by exposure to the sun and partly under cover; no artificial heat was used at any stage in the process.

The samples comprised three American tobaccos—viz. "Boyd," "Yellow Pryor" and "Sterling," and one native type. The characters of the leaves are shown in the following table:

	No. 1. Boyd.	No. 2. Native.	No. 3. Yellow Pryor.	No. 4. Sterling.
Size of leaves, length	15–25 in.	10½–17 in., mostly 16½ in.	15–24 in.	12½–20 in.
,, ,, width	5½–13 in.	2½–6 in., mostly 4½ in.	6–14½ in.	5–11⅓ in.
Colour . . .	Pale to medium reddish-brown; a few leaves of a pale yellowish-brown tint.	Light brown to medium brown with a reddish to orange tint; a few leaves mottled yellow and dark brown.	Pale to medium reddish-brown; a few leaves mottled.	Uneven, varying from light to medium reddish-brown; a few leaves slightly mottled.
Texture . . .	Of fair substance on the whole; a few leaves thin and weak.	Rather thin and in some cases weak.	Mostly of fair substance; some thin and rather weak.	Moderately thick and of fair substance.
Moisture in leaves, as received, *per cent.*	14·3	13·6	13·4	12·7

The samples on the whole were in good condition, but many of the leaves showed marks and a few torn leaves were present. All the tobaccos held fire well when burnt, but they gave off a rather pungent smoke.

The results of chemical examination expressed on the material conditioned to contain 12 per cent. of moisture are shown in the following table:

		No. 1. Boyd.	No. 2. Native.	No. 3. Yellow Pryor.	No. 4. Sterling.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture		12·0	12·0	12·0	12·0
Nicotine		4·2	3·9	4·1	4·4
Nitrogen		2·9	2·3	3·5	2·7
Ash		17·5	15·0	17·6	14·5
The ash contained:					
Lime	CaO	28·9	29·8	31·5	32·4
Magnesia	MgO	6·9	7·5	6·4	7·7
Potash	K_2O	17·4	17·9	17·1	17·7
Soda	Na_2O	2·1	1·9	1·9	1·4
Sulphates expressed as sulphuric acid	SO_3	1·3	1·1	1·5	1·4
Chlorides expressed as chlorine	Cl	0·9	2·4	1·7	1·0